Validation of the Microsoft Kinect as a Portable and Inexpensive Screening Tool for Identifying ACL Injury Risk

Aaron D. Gray, MD[1], Jeff M. Marks[2], Erik E. Stone[3], Michael C. Butler[3], Marjorie Skubic, PhD[3], Seth Lawrence Sherman, MD[2]

[1]University of Missouri Department of Orthopaedic Surgery, USA, [2]University of Missouri, Columbia, MO, USA, [3]University of Missouri College of Engineering, Columbia, MO, USA.

Objectives: A widespread screening tool to assess anterior cruciate ligament (ACL) injury risk should ideally be portable, inexpensive, markerless and easy to use. We hypothesize that our software program - for use with the Microsoft Kinect Motion Sensor - fulfills the above requirements. This study compares the measurements of knee abduction during a drop vertical jump (DVJ) between the Microsoft Kinect and the "gold standard" marker-based Vicon motion analysis system.
Methods: Thirteen participants (10 male: 3 female; age 20-31) took part in this IRB approved study. Each participant performed between 5 and 7 DVJs, yielding a total of 84 DVJs. We simultaneously measured knee valgus motion (KVM) as measured from initial contact (IC) to the point of peak flexion (PF), frontal plane knee angle (FPKA) at both IC and PF, and knee-to-ankle separation (KASR) ratio measured at PF with the Kinect and Vicon systems. The intra-class correlation coefficient (ICC) (two-way, single measure, absolute agreement) was used to assess the degree of agreement between the Kinect and Vicon for each measure.
Results: KVM had the lowest ICC value; 0.81 and 0.85 for the left and right leg, respectively. The other measures had similar ICC values of approximately 0.89 for both legs. Standard interpretations of the ICC suggest values above 0.75 indicate excellent agreement between the measurements (Table 1).
Conclusion: This study demonstrates good correlation between the Microsoft Kinect and the Vicon system for measuring frontal plane knee kinematics during the DVJ. The DVJ test has been established as an ideal task for evaluating the motions that put athletes at risk for ACL injuries. Screening and early detection of ACL injury risk factors may lead to a relative risk reduction between 30% to 80% with an appropriate ACL injury prevention program. As compared to the "gold standard" Vicon system, the Microsoft Kinect is a portable, inexpensive, marker-less, and expedient system that likely has acceptable accuracy to become a practical means of mass screening of athletes for ACL injury risk factors. Further study will focus on validating the system with a larger and varied sample size and over a variety of functional tasks.

TABLE I
DIFFERENCE BETWEEN KINECT AND VICON

	Left Leg		Right Leg	
	Error (u±σ)	ICC (95% int.)	Error (u±σ)	ICC (95% int.)
Knee Abduction Motion (mm)	0.38±14.51	[0.72,0.87]	5.38±15.72	[0.77,0.91]
Fr. Plane Knee Angle at IC (deg)	-1.19±1.88	[0.74,0.95]	-0.77±1.69	[0.81,0.94]
Fr. Plane Knee Angle at PF (deg)	-1.84±3.21	[0.77,0.95]	-0.09±3.75	[0.85,0.93]

	Error (u±σ)	ICC (95% int.)
Knee-to-ankle Separation Ratio at PF	-0.06 ± 0.12	[0.84, 0.93]

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